

ANNUAL REPORT
OF THE
DIRECTOR OF AERONAUTICS

TO THE
SECRETARY OF COMMERCE

FOR THE
FISCAL YEAR ENDED JUNE 30, 1927



PRICE 5 CENTS

Sold only by the Superintendent of Documents, U. S. Government Printing Office
Washington, D. C.

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON

1927

CONTENTS

I. ORGANIZATION OF THE AERONAUTICS BRANCH IN THE DEPARTMENT OF COMMERCE

	Page
Air regulations division.....	2
Airways division (Bureau of Lighthouses).....	4
Navigation facilities on civil airways.....	4
Radiobeacons and telephones.....	5
Weather service and communications.....	5
Engineering construction and maintenance.....	6
Beacons.....	6
Intermediate field lighting.....	7
Maintenance of airways.....	7
Improvement in apparatus.....	7
Program of lighting.....	8
Air information division.....	10
Information bulletins.....	10
Domestic air news.....	10
Mapping.....	10
Certification of lights.....	11
Airway bulletins.....	11
Airway mapping (Coast and Geodetic Survey).....	11
Aeronautical research division (Bureau of Standards).....	12
Radio aids.....	12
Lighting.....	14
The 1928 research program.....	14

II. DEVELOPMENT OF CIVIL AERONAUTICS

Air transport.....	15
Development of airways in America.....	15
First contract routes.....	15
First night service.....	16
To-day's air routes.....	16
Commercial air service.....	17
Private flying.....	17
Government participation.....	17
Airports and landing fields.....	18
Departmental cooperation.....	18
Air marking of cities.....	19
Equipment-design progress.....	19
Weather and flight.....	20
Air accidents.....	21
Casualties in airway flying.....	21
Casualties in miscellaneous flying.....	21
Aircraft production and trade.....	21
Exports.....	22
Trade promotion.....	23

III. CONCLUSION

Aim of the aeronautics branch.....	23
------------------------------------	----

OFFICE OF THE DIRECTOR OF AERONAUTICS

DEPARTMENT OF COMMERCE,
OFFICE OF THE DIRECTOR OF AERONAUTICS,
Washington, July 1, 1927.

HON. HERBERT HOOVER,
Secretary of Commerce.

DEAR MR. SECRETARY: In response to your request the following report is submitted, describing the state of air traffic and the aeronautic industry and briefly summarizing the activities of the aeronautics branch of the department during the fiscal year ended June 30, 1927:

I. ORGANIZATION OF THE AERONAUTICS BRANCH IN THE DEPARTMENT OF COMMERCE

The air commerce act, approved May 20, 1926, provided comprehensively for the promotion and regulation of civil aeronautics. Among other things it provided for the establishment and maintenance of civil airways, and their equipment with intermediate landing fields, beacon lights, signal and radio apparatus, and other aids to air navigation; the establishment of air traffic rules; the inspection and licensing of aircraft, the examination and licensing of airmen, and the identification of aircraft; the collection and dissemination of information pertaining to air commerce and the state of the art, including data concerning the causes of accidents; the establishment of a suitable weather service on airways; the charting of airways, and the publication of air maps; the promotion of air commerce, industry, and trade; and the conduct of scientific research and development work tending to the improvement of facilities for air navigation. The act provided for the rating of air ports as to suitability, and for the encouragement of the establishment and maintenance of air ports by municipalities.

The act did not create a new bureau in the Department of Commerce to perform these functions. The intention was that, so far as practicable, the duties imposed by the act should be distributed among existing agencies of the department.

Accordingly, the task of establishing, maintaining, and operating aids to navigation along air routes was assigned to the Lighthouse Service; the mapping of air routes to the Coast and Geodetic Survey; and the scientific research for the improvement of air-navigation aids to the Bureau of Standards.

The department had no facilities for the examination and licensing of aircraft and airmen, for the enforcement of air-traffic rules, or for the collection and dissemination of aeronautical information. It was necessary to set up new instrumentalities to deal with these matters, and two special divisions were accordingly established—the division of air regulations and the division of air information. For convenience of reference, these two divisions, together with the airways division of the Bureau of Lighthouses, the airway-mapping

section of the Coast and Geodetic Survey, and the aeronautical research division of the Bureau of Standards, are collectively referred to as the aeronautics branch of the department.

During the fiscal year 1927 the work of the respective divisions of the aeronautics branch was directly supervised by the Assistant Secretary for Aeronautics, provided for by the air commerce act. On July 1, 1927, the Secretary of Commerce appointed a Director of Aeronautics, who, under the general direction of the Assistant Secretary for Aeronautics, now has immediate charge of the department's work under the air commerce act.

The appropriations of the aeronautics branch for the fiscal year 1927 aggregated \$550,000, in addition to which certain amounts appropriated for the fiscal year 1928 were available for expenditure in the latter part of 1927.

The work of the several divisions constituting the aeronautics branch during the fiscal year, 1927, is summarized below.

AIR REGULATIONS DIVISION

The organization of this division presented one of the most difficult of the year's problems. Its work includes the inspection of aircraft for airworthiness and their registration as aircraft of the United States; the examination and licensing of airmen serving in connection with licensed aircraft; the identification by letter and number of all aircraft, including those not licensed; the investigation of accidents; the enforcement of air-traffic rules; and the rating of air-navigation facilities.

Necessarily the first step was the preparation of the regulations provided for in the air commerce act. There was no precedent for such regulations. Aircraft operations and activities in the United States are on a broader scale and more diversified than in other nations; and the regulations had to take into account existing types of war surplus and rebuilt aircraft as well as anticipate new construction of known types and the development of new types. These things made the drafting of regulations a most difficult and complicated problem. At the same time it was necessary to establish and define classes of licenses for airmen, both pilots and mechanics, and to prepare for their suitable qualification by means of tests and examinations, including tests of physical fitness.

The regulations, as finally adopted and made effective on December 31, 1926, were the result of numerous conferences attended by representatives from every interested branch of aeronautics. They provided in detail for the inspection, registration, and licensing of aircraft, the examination and licensing of pilots and mechanics, and the identification of all aircraft not licensed; and they set up the air traffic rules.

The personnel of the air regulations division must obviously possess unusual qualifications. Excepting clerical and office workers, they must be especially expert in the various phases of aeronautics. Aeronautical engineers and inspectors are required capable of advising with manufacturers and technicians and determining the airworthiness and suitability of new aircraft, both prior to and during construction, including the examination and checking of technical data, drawings, and diagrams. The inspection of aircraft and the exami-

nation and licensing of pilots and mechanics require a force of inspectors skilled in the maintenance and operation of aircraft, with piloting ability well above the average, and with good personality.

The act provided for a determination of the physical fitness of licensed pilots, and of applicants for license—a service that can be performed only by physicians with knowledge of flight requirements. In considering the work of the air regulations division, it should be remembered that a continuing inspection service for licensed aircraft must be maintained, and that the physical fitness of licensed pilots must be checked at suitable intervals.

During the fiscal year 1927 a good beginning was made in the establishment of the staff of the division and the procurement of necessary equipment. A medical director was appointed to organize the work of giving physical examinations to pilots and to applicants for pilot's licenses, and about 200 physicians and surgeons at various points throughout the country were designated as medical examiners for the aeronautics branch. Fifteen experienced men were given appointment as aircraft and engine inspectors, forming the nucleus of an inspection force which within a year is expected to reach 50. The duties of these men include also the examination of applicants for pilots' and mechanics' license.

In order to facilitate the inspection and examining work it was planned to equip the air regulations division with a limited number of airplanes, and 10 had been purchased or contracted for by the end of the fiscal year, of which 5 had been placed in operation. The department made an effort to adapt to its uses several surplus planes from the War and Post Office Departments, but these planes were not suitable for the department's requirements.

By the close of the fiscal year the air regulations division was fairly well organized, and work of examining applicants for licenses, and inspecting, numbering, and certificating aircraft, was proceeding.

It is estimated that less than half of the total number of airmen in the country have applied for license, and applications have been submitted for the registration or identification of only a small proportion of aircraft in operation. The requirements of the department are not yet fully understood, and many operators will probably delay the submission of applications until the department's representatives get in personal touch with them in the field. Until the staff of inspectors has been substantially enlarged this condition will continue to a greater or less extent. It is estimated that additional civil planes are now being placed in operation at the rate of over 100 a month, and this will increase the air regulations division's problem of bringing all civil craft and their operating personnel under the system of registration and inspection.

The duty of enforcing the air traffic rules as well as the investigation and assessment of penalties for violations devolves upon the air regulations division. These rules are analogous to rules of the road for ground traffic and cover minimum heights at which aircraft may be flown, acrobatic flying over congested areas, crossing aircraft, right of way, dropping objects from aircraft in flight, weather and distress signals, and the display of lights during night flights.

Because of the pressure of the work of examining and licensing aircraft and their personnel, the air regulations division was unable to fulfill its obligations in the examination and rating of airports

and landing facilities. It is apparent that a larger personnel with adequate air transportation will be required if the department is to meet fully its responsibilities under the air commerce act. The number of airports and landing fields has grown beyond any reasonable anticipation, and it is essential that this phase of the inspection work be given attention during the coming year.

AIRWAYS DIVISION (BUREAU OF LIGHTHOUSES)

The work of the airways division is carried on under the laws, rules, and regulations applicable to the lighthouse establishment, and so far as practicable through the regular district organization of the Lighthouse Service.

For convenience of administration the airways division is organized in four sections: Administration, extension and construction, maintenance, and weather and communications.

The section of extension and construction is further subdivided into three parts: Survey, for the laying out of airways over the best flying country and the location of intermediate landing fields; lighting, for the installation of lighted aids; and radio construction, for the installation of radiobeacons and radiotelegraph and telephone stations. At the close of the year the personnel of the engineering and construction section included 16 licensed air pilots and 12 engineers.

The maintenance section, responsible for the maintenance and operation of navigation facilities of all types along air routes, carries on its work through the regular district organizations of the Lighthouse Service, augmented by the necessary special personnel. Work in connection with air-navigation facilities has been assigned to lighthouse districts as follows: Third lighthouse district, Staten Island, N. Y., airways from Boston to New York and from New York to Bellefonte; tenth lighthouse district, Buffalo, N. Y., airways from Bellefonte to Bryan; twelfth lighthouse district, Milwaukee, Wis., airways from Bryan to Omaha, from St. Louis to Chicago, and from Dallas to Chicago; eighteenth lighthouse district, San Francisco, Calif., airways from San Francisco to Reno, Los Angeles to Salt Lake City, and Los Angeles to San Francisco and Redding. An additional office was established at Salt Lake City for the maintenance of airways from Omaha to Reno, Salt Lake City to Pasco, and Pueblo to Cheyenne.

The weather and communications section is responsible for the coordination of Weather Bureau forecasts in connection with the special requirements for meteorological service on civil airways and for the maintenance of a communication system designed to secure safety of flight.

On June 30, 1927, 134 persons were on the roll of this division.

NAVIGATION FACILITIES ON CIVIL AIRWAYS

The 1927 appropriation of \$300,000 for air-navigation facilities was expended for the establishment of lighting facilities on 1,386 miles of airways. Five routes were included in this mileage, all operated by air-transport companies carrying mail on regular schedules that made it necessary to fly into total darkness at the extremities of the routes. The routes were New York to Boston, St. Louis to Chicago, Dallas to Chicago, Salt Lake City to Pasco, and Los Angeles

to Salt Lake City. Thirty-two lighted intermediate fields were placed on the five routes, and 107 airway lights were established.

Of the 1928 appropriation for air-navigation facilities, \$450,000 was available for expenditure on February 24, 1927. From this sum preparations were made to light 1,294 additional miles of airways, and contracts were actually awarded during the fiscal year 1927 for lights on 694 miles.

These contracts provided for lighting one additional route, Pueblo to Cheyenne, and for completing the lighting on the Dallas-Chicago route. Surveys of the routes from Atlanta to New York, from Chicago to Twin Cities, from Detroit to Grand Rapids, and from Los Angeles to San Francisco were under way during the latter part of the year, preparatory to the establishment of intermediate fields and airway lights.

Under the provisions of the air commerce act, the transcontinental airway was transferred to the Department of Commerce at the close of June 30, 1927. The airway extends from New York to San Francisco, 2,612 miles. The facilities on the lighted section from Salt Lake City to New York, 2,041 miles, consist of 92 intermediate fields with beacons and boundary lights, 612 electric and acetylene gas beacons, and 17 radio stations. One hundred and forty-six employees were transferred with the airway. Including the transcontinental, there were, at the close of the fiscal year, 4,121 miles of lighted airways under the jurisdiction of the Department of Commerce, the facilities totaling 124 intermediate fields with beacon and boundary lights, 719 airway beacons, and 17 radio stations.

RADIOBEACONS AND TELEPHONES

A radio equisignal range beacon for aircraft was established at Hadley Field, New Brunswick, N. J., where experimental work has been conducted looking to the development of small airplane receivers suitable for single-pilot planes. Another radiobeacon was installed on the transcontinental airway at Bellefonte by the Bureau of Standards, and experimental work is being carried on at this station also. A third installation is contemplated at Cleveland, where it is expected to carry on radio development work under operating conditions.

Safety of navigation requires that information regarding landing and weather conditions be made available to air pilots approaching terminal fields, as well as periodic information as to changes in barometric pressures at points of known elevation for adjustment of the altimeter while in flight. Installations of radiotelephones to communicate information of this sort to aircraft in flight are being planned, and experimental installations are now in progress at Hadley Field and Bellefonte.

WEATHER SERVICE AND COMMUNICATIONS

The Weather Bureau of the Department of Agriculture has established during the fiscal year 22 new upper-air meteorological stations in addition to 15 existing ones, many of which are located at airports. Weather data collected throughout the United States are transmitted to Weather Bureau offices twice daily, and forecasts of flying conditions are made available to pilots taking off at all terminal fields.

A system of communication is being established under which the maintenance personnel on the airways will furnish to the Weather Bureau forecasters additional information regarding local storms, fogs, and weather changes. On the transcontinental airway 28 weather reporters were engaged in furnishing data to terminal fields on June 30, 1927. There are 17 radio stations on this airway, providing facilities for the transmission of weather information as well as information concerning the arrival and departure of planes from various terminal fields, the particulars of cargo and passengers carried, and emergency messages designed to facilitate and safeguard traffic. This system provides the fast communication which is essential in connection with air transport, and as rapidly as funds permit it is planned to extend it to all airways. At the present time weather information and essential messages are transmitted by telephone on all airways except the transcontinental.

ENGINEERING CONSTRUCTION AND MAINTENANCE

Airways established during the past year were surveyed and laid out by the survey branch of the section of extension and construction, the personnel employed consisting of licensed air pilots and engineers.

The airways follow the best flying country between designated airports, determined after a reconnaissance survey made by airplane flights. Intermediate landing fields averaging about 40 acres in extent are located about 30 miles apart between airports.

Experience of the past year has indicated that at sea-level elevation landing strips about 400 feet wide and not less than 1,800 feet long, are required on auxiliary fields, generally in two directions, giving four directions in which landings can be effected. Longer strips are necessary at higher altitudes to compensate for lessened air density and reduced engine efficiency. The majority of fields are L or T shaped. The surface should be fairly level, with clear approaches, and there must be good drainage. The fields should be located close to the highways to provide transportation facilities, and commercial power and telephone extensions are important considerations.

On a great number of fields in farming sections no grading or improvements to the land have been found necessary. In other sections, particularly in the West and Southeast, considerable grading and clearing of land is required. Where clearing and grading were needed the average cost per acre was \$11 during the year.

The fields are licensed for from two to five years, but the licenses continue in force indefinitely, subject to six months' notice of removal, either by the owner or the Government. The average rental is from \$8 to \$10 an acre per year.

BEACONS

Beacon sites are located about 10 miles apart between intermediate fields. A plot 15 by 60 feet is required for each site, and the rental averages \$25 a year. Where the flying terrain is bad, closer spacing of lights, and special lights marking buttes, obstructions, mountain passes, and other natural features are necessary.

The beacon towers are 50 feet high, of light galvanized structural steel, with a 6-foot square platform upon which a 24-inch standard

revolving beacon, 6 RPM, is mounted. The standard beacon, using a 1,000-watt T-20 electric lamp and 24-inch parabolic mirror, has a candlepower of 2,000,000. The lights are elevated 2° above the horizon. Where commercial electric power is available sun relays or astronomic clocks automatically control the light and no caretaker is needed. Otherwise a 2-kilowatt engine generator set is installed in a small power house. Part-time caretakers are employed to operate the beacon lights in these instances.

A concrete arrow is laid out at the base of the beacon tower pointing along the direction of the airway. Beacon numbers are painted on the power-house roof or the feather end of the concrete arrow, in black figures on a chrome yellow background.

INTERMEDIATE FIELD LIGHTING

A standard beacon is also installed at each intermediate landing field. The field is outlined with white boundary lights spaced about 300 feet apart, with green range lights showing the approaches to the field and red lights on all obstructions. Parkway cable is laid underground around the field for furnishing current to the boundary lights. The field is ground-marked for day flying with a white circle 50 feet in diameter and runway indicators 20 feet long by 2 feet wide at the intersection of runways showing the landing directions. In addition, corner strips show the extremities of the field. An internally lighted wind cone attached to a bracket on the side of the tower shows the wind direction.

Special equipment including towers, beacons, lamp-control apparatus, relays, engine generators, and wind cones are purchased by the Government and turned over to the general contractor for erection, this procedure being most advantageous, economical, and expeditious. The average cost of installing lighting facilities on an intermediate field is \$5,500, and the average cost of the standard-airway beacon is \$2,400.

MAINTENANCE OF AIRWAYS

The airways are maintained under the general supervision of the Lighthouse Service district offices. Each airway is divided into sections, each section being in charge of an airway mechanic who is held responsible for the maintenance and operation of his section. Transportation is provided by means of a 1½ ton panel-body automobile truck equipped with all necessary spare parts and tools for taking care of practically any emergency repair job encountered. At the close of the year there were 31 airway mechanics and 161 caretakers in charge of 4,121 miles of lighted airways, with 590 automatic acetylene and electric aids. Intermediate field equipment and airway beacons are serviced at least once each month.

IMPROVEMENT IN APPARATUS

Much was accomplished in the development of improved airway apparatus and structures during the year. The 24-inch rotating airway beacon has been improved by the addition of a flashing mechanism for identifying lights. The motor of the beacon is employed for the driving mechanism, thereby synchronizing the supplementary lights with the flash of the beacon. An improved and

reliable lamp exchanger for the beacons has been developed commercially. Airway structures have been numbered on a mileage basis for identification of location with respect to the airway. This numbering system has been incorporated in the lighting system in order that the distinctive characteristic may locate the beacon for the pilot aloft. The standard airway tower is now entirely suitable. A flashing electric beacon using a 360° Fresnel lens and top section showing from the horizon to the zenith, and so designed that equal candlepower is visible to the pilot approaching the light, is now being tried out at Beacon No. 6 on the Los Angeles-Salt Lake airway. Astro-nomic time clocks have been introduced for the control of automatic lights. Improvements have been made in the design of the internally lighted wind cone, making the device more reliable and eliminating the slip rings carrying current to the lights.

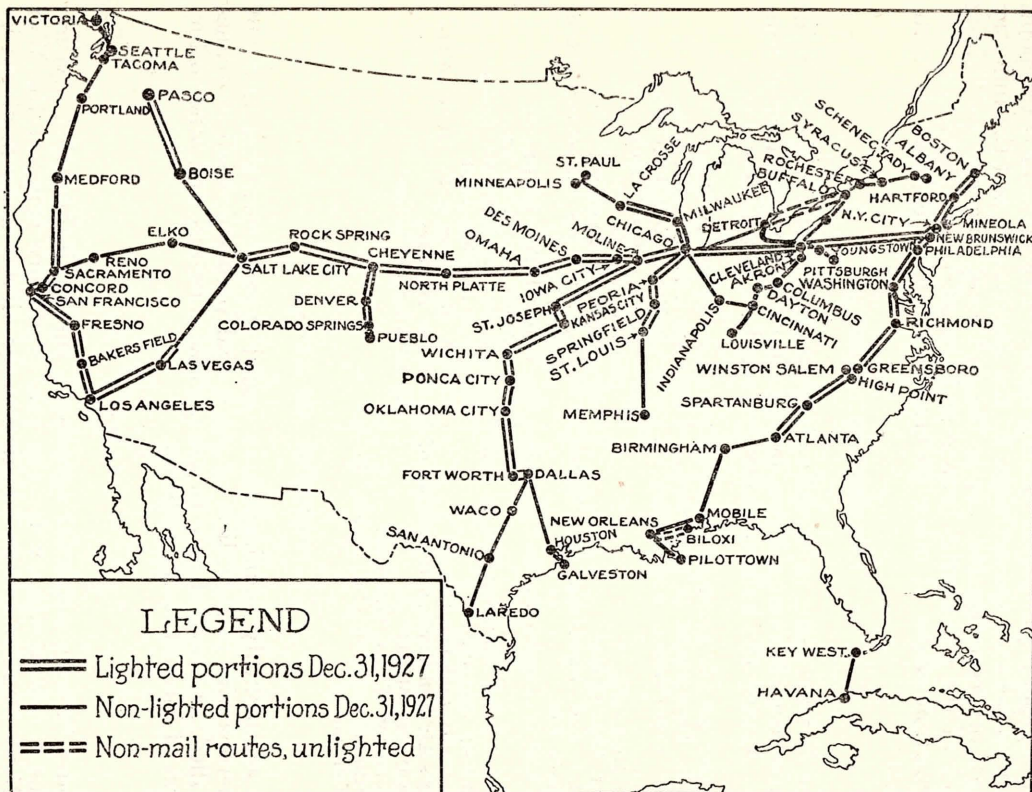
PROGRAM OF LIGHTING

The following list shows the status of the establishment of air navigation facilities on airways in the United States and projected airways to be considered for future establishment:

Routes lighted by June 30, 1927:		Routes to be considered for fiscal year 1929:	
	Mileage		Mileage
Transcontinental airway ¹ -----	2, 041	Cleveland-Detroit-----	155
New York-Boston-----	219	Los Angeles-Seattle (to complete)-----	590
St. Louis-Chicago-----	268	Chicago-Twin Cities (to complete)-----	135
Dallas-Chicago-----	501	Miami-Atlanta-----	633
Salt Lake-Pasco-----	110	Dallas-Galveston-----	267
Los Angeles-Salt Lake (partial)-----	288	Cleveland-Albany-----	446
Pueblo-Cheyenne (under contract)-----	200	Dallas-Laredo-----	395
Dallas-Chicago (under contract)-----	494	New Orleans-Atlanta-----	483
Total-----	4, 121	Boston-Albany-----	141
		New York-Albany-----	160
		Atlanta-St. Louis via Birmingham and Memphis-----	593
		St. Paul-Winnipeg (to United States border)-----	365
		Albany-Montreal (to United States border)-----	117
		Jacksonville-Savannah-Charleston-Norfolk (sea-plane airway)-----	810
		Pittsburgh-Cleveland-----	121
		Key West-Miami-----	128
		Chicago-Indianapolis-Cincinnati-----	267
		Birmingham-Louisville via Nashville-----	341
		Tampa-Titusville-----	110
		Total-----	6, 257
Routes to be lighted by June 30, 1928:			
New York-Atlanta-----	757		
Los Angeles-Seattle (partial)-----	562		
Chicago-Twin Cities (partial)-----	274		
Salt Lake-Pasco (partial) ² -----	500		
San Francisco-Salt Lake-----	615		
Los Angeles-Salt Lake (to complete)-----	345		
Louisville-Cleveland-----	345		
Total-----	3, 398		

¹ The navigational facilities between Salt Lake City and New York on the transcontinental airway were established by the Post Office Department before the route was transferred to the Department of Commerce.

² Includes 110 miles of reconstruction.



Airway lighting program as of December 31, 1927

AIR INFORMATION DIVISION

The air information division is concerned with the collection and dissemination of information on civil aeronautics, domestic and foreign; the charting and publishing of information on airways, airports, and meteorological and other aids to flying; the encouragement of airport construction and other aids to navigation; the development of air commerce, including domestic and foreign trade in aircraft; and the general promotion of civil flight. The division is the point of contact between the activities of the department and the industry and all others interested. It is the fact-compiling and publishing agency of the aeronautics branch and the office for liaison with the information offices of other governmental bodies engaged in aeronautics.

INFORMATION BULLETINS

The division issues information bulletins on various subjects. Some of these are continuing series, brought up to date by corrected reissues. Among the bulletins already issued are the following:

Statement of Air Activities and Programs, Department of Commerce.	Marking of Obstructions.
Airport Construction and Rating: 2 parts.	1926 Air Service Operations.
Trade Directory.	Aircraft Production, 1919-1926.
List of Aero Clubs.	Government Departments in Aeronautics.
Airports and Fields in the United States: List.	Aeronautics in Business.
Short List of Air Publications, by subjects.	Casualty Statistics (in course of compilation).
Map of United States Airways, continuously corrected.	Air Traffic Rules, illustrated.
The Airport and the City.	Aeronautics as a Vocation.
To-day's Air Commerce, a tabulation of airway operations.	Compilation of State Air Laws.
Development of Air Transport.	Airway Statistics, 1926.
Department Intermediate Fields, Requirements of.	Airway Statistics, 1927 (first half).
	Airplane Hangars.
	Airmarking for Cities.

DOMESTIC AIR NEWS

A semimonthly publication is issued which furnishes news of the aeronautics branch, lists of pilots and planes licensed or planes identified, locations of new airports, traffic statistics, and other information of interest to the industry.

MAPPING

Under interdepartmental agreement, the air information division acts as a central agency for the sale of airway maps of the War and Navy Departments in addition to the airway maps produced by the Coast and Geodetic Survey.

The program of the Department of Commerce includes the production of 37 strip flight maps which, with the nearly completed 52-map program of the War Department, will cover all airways at present projected. The Hydrographic Office of the Navy has produced three of its planned 58 air charts along the Pacific and Atlantic coasts, the West Indies, Mexico (west coast), and Central

America. The maps to be produced under the department's program are as follows:

- | | |
|---------------------------------------|--|
| 101. Galveston-Houston-Dallas. | 120. Albany-Boston. |
| 102. Dallas-Oklahoma City. | 121. New York-Albany. |
| 103. Oklahoma City-Wichita. | 122. Albany-Montreal. |
| 104. Wichita-Kansas City. | 123. Miami-West Palm Beach-Titusville. |
| 105. Kansas City-Moline. ³ | 124. Tampa-Titusville. |
| 106. Pilottown-New Orleans. | 125. Titusville-Jacksonville. |
| 107. New Orleans-Jackson. | 126. Jacksonville-Atlanta. |
| 108. Jackson-Memphis. | 127. Birmingham-Atlanta. |
| 109. Memphis-St. Louis. | 128. Atlanta-Greensboro. |
| 110. St. Louis-Chicago. | 129. Greensboro-Richmond. |
| 111. Chicago-Milwaukee. | 130. Richmond-Washington. |
| 112. Milwaukee-Twin Cities. | 131. Pueblo-Cheyenne. |
| 113. Twin Cities-Fargo. | 132. Los Angeles-Las Vegas. |
| 114. Cincinnati-Indianapolis-Chicago. | 133. Las Vegas-Milford. |
| 115. Cincinnati-Dayton-Cleveland. | 134. Milford-Salt Lake City. |
| 116. Cleveland-Buffalo. | 135. Salt Lake City-Boise. |
| 117. Milwaukee-Grand Rapids-Detroit. | 136. Boise-Pasco. |
| 118. Detroit-Buffalo. | 137. Pasco-Seattle. |
| 119. Buffalo-Albany. | |

The demand for maps on the part of commercial operators, individual flyers, industrial concerns employing airplanes for the travel of executives, and contestants in various events is constantly increasing.

CERTIFICATION OF LIGHTS

Air-navigation lights installed by private enterprise are certified and registered, and information concerning them published in bulletins. The private lights which have already been installed or are in project indicate the probability of a large number of these about the country on and off designated airways.

AIRWAY BULLETINS

Department of Commerce airway bulletins to the number of 112 have been printed and issued to pilots, manufacturers, and airports and others interested. These are illustrated loose-leaf sheets describing airports, Department of Commerce intermediate fields, and airways of the country; air marking, meteorological conditions; and other data necessary in air navigation. They have been published as fast as limited personnel would permit, the number of airports improved or newly constructed being at all times ahead of bulletin production.

AIRWAY MAPPING (COAST AND GEODETIC SURVEY)

The production of maps of civil air routes is assigned to the chart division of the Coast and Geodetic Survey, as an adjunct to its function of producing marine charts.

An effort is being made to produce accurate airway maps without special surveys. The maps are on a small scale (1:500,000). The aviator does not require a high degree of accuracy with respect to a multitude of minute details which would escape his attention during his rapid flight over the country. He does, however, require accu-

³ Only one of series completed June 30, 1927.

racy in the major features. Highways, railroads, and streams must be shown in their proper relation to each other. If a highway is shown on the wrong side of a railroad, it sooner or later will make trouble for the aviator. Again, it is not enough merely to show a power-transmission line following a road. The pilot must know at all times on which side of the road the line is located, as otherwise, flying low in thick weather in order to follow the road as a guide, he might collide with the line. These and other similar items require the most careful attention of the map compiler as the value of the map and the safety with which it can be used depend directly on the accuracy with which such features are shown.

The information used in the production of airway maps is derived from a variety of sources, such as the State maps and quadrangles of the Geological Survey, the post-route maps, highway maps of the Bureau of Public Roads, State and county maps, commercial publications, and, finally, a large amount of miscellaneous information secured from corporations or individuals operating aircraft, and Army, Navy, and civilian pilots. After information from these sources has been compiled it is necessary to verify the compilation by actual observation on the route. Although this may be accomplished in part by flight check, it is believed that it will prove more satisfactory to send qualified engineers over the terrain by automobile to indicate, after inspection, the corrections necessary to make the map accurate and reliable for flight purposes. The 1928 mapping program contemplates work of this character.

Four men were added to the personnel of the chart division during the fiscal year 1927 for work on airway maps. With this force four months is required for the production of one map. The personnel will be enlarged during the coming year.

During 1927 one map (from Kansas City to Moline) was completed. Five others were partially completed and are now ready for flight check. It is expected that by the close of the fiscal year 1928 maps of the following routes will be wholly or partially completed, and at least three will be available for distribution:

- | | |
|-----------------------------|------------------------------|
| 102. Dallas-Oklahoma City. | 112. Milwaukee-Twin Cities. |
| 103. Oklahoma City-Wichita. | 128. Atlanta-Greensboro. |
| 104. Wichita-Kansas City. | 129. Greensboro-Richmond. |
| 110. St. Louis-Chicago. | 131. Pueblo-Cheyenne. |
| 111. Chicago-Milwaukee. | 134. Milford-Salt Lake City. |

AERONAUTICAL RESEARCH DIVISION (BUREAU OF STANDARDS)

Of the research and experimental work contemplated by the air commerce act, two fundamental problems were taken up by the Bureau of Standards during the fiscal year 1927, first, the development of radio aids to air navigation, and, second, the improvement of lighting facilities.

RADIO AIDS

Active work on the aeronautical radio problems was started at the Bureau of Standards July 1, 1926. Arrangements having been completed for the lease of the former air mail field at College Park, Md., and one hangar, contracts were awarded for the construction of a

wooden tower and house for a directive radiobeacon and an office, storeroom, and radio room in the hangar building.

These housing facilities were completed in October. Meanwhile equipment for the beacon was being accumulated and orders were placed for needed supplies. A DH airplane, a 1-kilowatt radiotelephone transmitting set, and several other useful items were transferred from the Post Office Department.

By December installation of the equipment of the first model of directive radiobeacon was completed and initial tests made. The technical members of the staff completed their first studies made toward a solution of the problem of a visual indicator for airplane use to be employed with the directive beacon.

Much time was consumed in getting organized. The bureau undertook the project without any equipment, air field, or airplane. By December, 1926, most of these essentials had been provided and test flights were being made with the first model visual indicator and a new type directive radiobeacon transmitter. The first experiments indicated that the visual system had possibilities and also that the course was likely to be sharper and more easily flown than with the aural system already in use by the War Department at McCook Field. A small marker beacon was also constructed at College Park during the period.

To enable radiotelephone communications to and from the airplane to be carried on, a loan of the former WCAP station at Washington was secured from the American Telephone & Telegraph Co., who also generously provided suitable control lines between that station and College Park, as well as to the Bureau of Standards and the Department of Commerce.

The success attained with the College Park installation determined the bureau to undertake the construction of another similar unit at a point on the transcontinental air mail route. The Bellefonte, Pa., air field was selected in cooperation with the Post Office Department as the most useful location for this purpose because of the unfavorable flying weather conditions in that region, and the work on this project was initiated in March, 1927.

On June 30 the Bellefonte radiobeacon station was in operation, a Post Office Douglas airplane made ready to be equipped with radio apparatus, and all materials needed for the radiotelephone transmitting set delivered to the site. A former Post Office radio station consisting of two 100-foot masts and a two-room building was rehabilitated for use as a remotely controlled transmitting station.

In May, 1927, the bureau exhibited the directive radiobeacon and radiotelephony to and from airplanes at the All-American Air Display held at Washington. Following this an experimental flight was made from Washington to Detroit, telephonic communication being maintained with Washington for 100 miles. In June the bureau equipped an airplane which broadcasted the events of the arrival of Colonel Lindbergh at Washington. A triple-engined all-metal monoplane was lent through the courtesy of the Ford Motor Co. for these flights.

As a result of the work at College Park the Bureau of Standards feels that three items of its aeronautical radio program, namely, the directive radiobeacon with visual indicator, radiotelephony to air-

planes, and the radio marker beacon, are ready for actual trial in daily use on an airway. While the visual indicator problem has not been satisfactorily solved, much progress has been made.

At the conclusion of the year the bureau finds itself ready with a completely equipped field laboratory and airplane at College Park, where development work is under way, and a complete experimental unit and airplane at Bellefonte, Pa., where service tests can be conducted over the New York-Cleveland section of the transcontinental air mail route.

Members of the staff have visited other agencies interested in these projects, such as the General Electric Co., the Ford Motor Co., and the Air and Signal Corps laboratories at Dayton. Contact has also been maintained with several of the air mail contractors interested in the project.

LIGHTING

Experimental work in the lighting of airways was begun on September 1, 1926. A study has been made of the literature on airway and landing-field lighting, and a report has been prepared on the use of neon lamps for such purposes.

Experimental work has been carried out with a lighthouse lens furnished by the Bureau of Lighthouses, which was mounted on an automobile chassis for use in measurements at College Park field. Through the courtesy of the General Electric Co. a 10,000-watt lamp was furnished for use with this lens.

Conferences were held with aviators, Army and Navy engineers, manufacturers of equipment, and consulting engineers as a basis for outlining a program of experimental work.

Laboratory experiments were made on two neon lamps. A parabolic reflector was designed and made for use with these lamps, and was found to increase the candlepower about 10 times. Field tests showed that over a range of about 2 miles the bare lamp was scarcely visible, but that it was plainly visible with the reflector. The lamp was not visible at night during heavy fog and rain.

Flying tests were made at the Naval Air Station, using Sperry landing flood lights, compared with B. B. T. flood-lighting equipment. Photometric data were determined on both of these systems.

A series of computations and curves have been made, showing the distribution of candlepower in a vertical plane required to give equal visibility at stated distances from an airplane flying at fixed altitudes.

THE 1928 RESEARCH PROGRAM

During the coming year work will be continued looking to the perfection of the radiodirective beacon and field-marker beacons and the further development of telephone communication between airplanes and the ground. It is expected also to take up a number of new problems, including a study of the distribution of the light from beacons and the relation of light color to effectiveness, an investigation of the strength of airplane joints and fittings of standard design, an investigation of the stability of planes of different types, and studies of methods of reducing airplane noises.

II. DEVELOPMENT OF CIVIL AERONAUTICS

America is doing a prodigious amount of civil flying. It may generally be divided into three classes: *Air transport*—scheduled operations over regular routes (mail, express, and passenger); *commercial air service*—such as “taxi” service, crop dusting and spraying, photography, over-city rides, tours, and so on; and *private flying*—including pleasure aviation and the travel of business men using airplanes in their daily affairs.

AIR TRANSPORT

To the surplus of aircraft at the conclusion of the war, and the experience in the carrying of messages, mail, and personnel by air during the war, may probably be ascribed the inauguration in Europe in 1919 of an airway system which has now been extended to cover Central Europe and reaches into Africa, Asia, and the far corners of the world.

A great passenger and express business has been developed in addition to air mail. The routes are supported in the main by subsidies, direct or indirect, amounting to a great sum annually. Many of these routes serve colonial possessions without regard to purely civil or commercial reasons.

DEVELOPMENT OF AIRWAYS IN AMERICA

As in Europe, prior to the World War no mail, passenger, or express air routes were continuously operating in the United States save for some seasonal short lines operated spasmodically and for occasional brief demonstrations in cooperation with the Post Office Department at air meets and exhibitions.

For a brief period in 1918 an experimental air-mail route was operated by the Post Office Department between New York and Washington, D. C.

In 1919 the Post Office Department initiated the transcontinental air mail route between New York, Chicago, and San Francisco. The operation of planes between Cleveland and Chicago was begun on May 15. On July 1 the operations were extended from Cleveland to New York.

Beginning May 15, 1920, the line was extended west from Chicago to Omaha, and on September 8, 1920, flying began between Omaha and San Francisco, completing combination daylight airplane and night train service across the continent. The mail was flown out of New York and put on a train in the evening at Chicago, taken off the train the following morning and flown the remainder of the route.

A route from St. Louis to Minneapolis-St. Paul was operated by the Post Office Department between December 1, 1920, and June 30, 1921.

FIRST CONTRACT ROUTES

On October 15, 1920, foreign-mail contract routes were inaugurated between Seattle and Victoria in the northwest and between Key West

and Habana in the southeast. The Seattle-Victoria route still continues operation. The Florida route was discontinued March 31, 1923, to be resumed in 1927.

Another foreign contract air-mail route began operation April 9, 1923, between New Orleans and Pilottown. The Seattle and New Orleans routes carry 2-cent mail to and from steamers and save many days.

A contract route was also operated between Fairbanks and McGrath, Alaska, from February 1 to June 30, 1924.

FIRST NIGHT SERVICE

On July 1, 1924, night flying began between Chicago and Cheyenne, this portion of the transcontinental route having been lighted by the Post Office Department. Subsequently lights were added between Chicago and New York to the east, and between Cheyenne and Salt Lake City to the west.

TO-DAY'S AIR ROUTES

As a result of the air mail act of February 2, 1925, with amendments, there has rapidly developed a great contract air-mail system, the nucleus of the now growing air-transportation net.

On January 1, 1926, the Post Office Department had the transcontinental mail route in operation both ways between San Francisco and New York, with an additional night service both ways between Chicago and New York; and the two foreign contract routes out of Seattle and New Orleans.

At various dates, beginning February 15, 1926, nine other contract routes were put into operation, and on June 30, 1926, the airway system consisted of 12 routes.

During the second half of the calendar year 1926 other routes were added and the Post Office Department advertised the transcontinental and New York-Chicago overnight routes for private operation. The contract for the section from Chicago to San Francisco (daily) was let to the Boeing Air Transport and for the section between Chicago and New York to the National Air Transport (daily and nightly). The Boeing company began operation July 1, 1927, and the National Air Transport was scheduled to begin September 1, 1927.

There were 55 station stops on the routes in operation on June 30, 1926. Over \$5,000,000 was invested in the contract airway system by the air-mail contractors in the calendar year 1926, and this sum was rapidly increased as new routes and new vehicles were added.

By the end of the calendar year 1926, 18 routes had been operated for mail or passengers, or both, and freight.

Save for that portion of the Government's route between Salt Lake City and New York, lighted by the Post Office Department, all civil airway flying before July 1, 1926, was done without lighting facilities. The economical use of the airplane demands flying by night as well as by day and in all vicissitudes of weather and season, and it is the purpose of the Department of Commerce, under the air commerce act of 1926, to furnish to air traffic those aids which will result in the

greatest degree of flight efficiency. Lighting of the airways was undertaken immediately upon the organization of the aeronautics branch in the fall of 1926, and before the end of the calendar year 1926 some lights were already placed in operation. On June 30, 1927, there were 4,121 miles of lighted airways, including the 2,041 miles on the transcontinental airway which had been lighted by the Post Office Department.

On July 1, 1927, there were 15 mail lines in operation and 9 more advertised for bids. In addition there were 3 nonmail routes. The 24 mail routes will serve 65,677,209 people in the various trading areas along these airways, with 75 station stops.

COMMERCIAL AIR SERVICE

By far the greatest volume of flying in America has been done by fixed-base and itinerant air-service operators—individuals, firms, and corporations engaged in taxi service, crop dusting, journalism, and news photography, sight-seeing, commercial photography and mapping, touring, flying instruction and other miscellaneous pursuits—utilizing light commercial planes of both new and war-surplus materials.

This class of operators has no parallel in any other country. The itinerant pilots have become fixed-base operators and this phase of commercial flying has settled down into solid business.

To the Post Office Department and air-service operators belong the credit for keeping flight before the public during the whole postwar period. Their pilots flew nearly 19,000,000 miles in 1926, according to the department's estimates.

PRIVATE FLYING

Unexpected purchasers at this comparatively early stage of general flight are the corporations and individual business men who have bought the most modern airplanes for business travel. Corporations, particularly, have put into service the largest cabin planes with triple engines.

There remains the sport and pleasure use of aircraft—private flying. This is developing very rapidly, and thousands of private owners will soon fly for pleasure in up-to-date, modern, inherently stable aircraft at a reasonable cost. Comparatively low-priced airplanes of new design and construction are now available and are quickly replacing the many war-surplus types that have been serving until the present time. Manufacturing and the development of additional aircraft will continue on an ever-increasing scale, and it is difficult even to venture a guess as to the limitations on this class of flying.

GOVERNMENT PARTICIPATION

The safe and continued development of all classes of operations depend largely upon the airworthiness of the aircraft employed, the competency of pilots, the establishment and maintenance of properly equipped airways, the enforcement of standard air traffic rules, and an adequate dissemination of information concerning facilities on airways and at airports. It is in these matters that the Government must render a very definite and comprehensive service.

AIRPORTS AND LANDING FIELDS

The inauguration of contract mail and other routes forced the establishment of new airports or the improvement of existing airdromes at every station stop along airways by the municipalities—either directly by the city or in its behalf by civic organizations, or by private enterprise.

Everywhere civic interest has been stirred by the progress of air transport, and cities all over the country, both on and off the airways, are working with the airport idea toward varying degrees of airport excellence. These airport facilities may be rated under the act. The value of the land and improvements varies greatly, running as high as \$1,000,000 or more at the larger ports.

At the close of the fiscal year 1927 there were recorded 864 municipal, commercial, or private airports, intermediate fields maintained by the Department of Commerce and unimproved but permanent landing fields, a great many of which were reconstructed or proposed for development in accordance with the standards suggested by the department.

In addition, airports of one grade or another were under discussion in 144 cities, with the number growing. It is estimated that about 1,000 airports will be in operation at the end of the fiscal year 1928. Of these a large portion will be municipal.

DEPARTMENTAL COOPERATION

Illustrated descriptive bulletins are published by the department on all airports as fast as conditions permit. The entire country is under a first annual canvass of unimproved auxiliary fields, of which there were approximately 3,000. A register of these is maintained for flights off scheduled routes.

The development of airports has been directly aided by the Department of Commerce through its Airport Bulletin and other publications. The bulletin covers, with illustrations, practically every subject connected with the construction and equipment of an airport. Some 4,000 copies have gone to cities, commercial organizations, engineers, editors, and others directly interested in airport development.

Personal advice and aid in the establishment of airports and the construction of terminal facilities have been given in scores of cities by the assistant secretary for aeronautics or the personnel of his office, while every imaginable phase of the subject has been covered by voluminous correspondence.

Representatives of the department have encouraged airport development in a great flying circuit of the country made in cooperation with the Daniel Guggenheim foundation. Commander Byrd's polar airplane carried his transpolar companion, Floyd Bennett, with a representative of the department to 45 cities in an 8,604-mile tour.

In a circuit of some 80 cities with Maj. H. A. Dargue, commander of the Army Air Corps' Pan-American "Good will tour," Walter O. Lochner, secretary of the National Association of Commercial Organization Secretaries, carried letters from the Assistant Secretary for Aeronautics urging the various commercial organizations of the

country to interest their communities in the development of aeronautics and the establishment of airports. A representative of the aeronautics branch made a tour of all the cities along the existing air mail routes, using various forms of transportation—air, rail, and motor. The primary purpose of the tour was to stimulate the use of the air mail, but the entire field of civil aeronautics received attention. Comments from business men and municipal and chamber of commerce officials indicated that this tour was very beneficial.

AIR MARKING OF CITIES

Thousands of cities are being air marked. During the year one oil company painted city names on most of its 4,200 stations in 10 States, and four other concerns are similarly marking towns in other States.

As the year closed the support of the governors of all States was enlisted in urging civic associations to push the program of marking. Every such organization has been furnished with uniform specifications as to size and colors.

A standard system of distinctive marking of obstructions, such as high tension power lines, radio towers, and similar obstructions, was drafted by an interdepartmental committee and is the subject of another department bulletin.

EQUIPMENT-DESIGN PROGRESS

The passenger-service airplane of to-day is so far advanced that it is difficult to realize that scheduled air transport service as we now know it is less than two years old.

We are still prone to think of the passenger airplane as the two-seated, open-cockpit affair of war and postwar days.

Heretofore the designer has been almost entirely engrossed with wing and power loading curves and resistance—flight efficiency along the particular line demanded.

Now, however, attention is being given to comfort and equipment. To-day one steps into a cabin-type aircraft, takes a comfortable upholstered seat with ample leg room, and departs himself in the same manner as in a closed automobile of the most modern construction.

The closed airplane has developed far more rapidly than the closed automobile. The leather coat, the helmet, and the various paraphernalia of the air traveler of yesterday have disappeared. Even the pilot of the modern passenger plane is inclosed in a comfortable, heated cabin with sliding or hinged glass windows, which may be opened for ventilation or for better visibility. The question of comfort is being given ever more serious consideration.

Into the plane itself has been built the inherent stability promised for a quarter century. Yet sacrifice has not been made of maneuverability and controllability.

One of the most striking features of late development has been the general application of brakes to airplane wheels, by which the landing roll is greatly reduced. Brakes on either wheel are independent in action so that they can be used for maneuvering on the ground.

Oleo pneumatic and oleo spring gears are being widely adopted for shock-absorption purposes on the landing gear and have proved very successful in improving landing characteristics.

In the design of the fuselage, wood and wire construction have been almost entirely superseded by welded steel tubing or other metal construction. Wings continue to be largely built of wood spars and ribs with fabric covering. Several manufacturers have, however, given attention to the construction of all-metal planes of duraluminum with a very thin sheet of the same material replacing the fabric, and more than one such design is in commercial use.

In general airplane design there is a tendency to revert to the monoplane which was used so extensively in early days of aviation. The visibility for both pilot and passengers is greatly improved over that of the multiplane type, and for the present demands upon commercial planes, monoplane construction presents no unusual problems for the manufacturer.

The weight of the power plant per horsepower has been materially reduced, and one of the newest engines has reduced the frontal area some 30 per cent. Improved propellers at the same engine speed in the identical airplane give greater efficiency. The air-cooled engine is being extensively used for commercial purposes because of its light weight, simplicity of installation, and reliability.

In the installation of the engine considerable attention is being given to exhaust manifolds which both reduce the noise of the engine and carry the exhaust gases clear of the passenger compartment.

Air-pressure systems for the gasoline supply have been almost entirely replaced by gear-driven pumps and gravity, and one of the greatest hazards—that of fire—has thus been practically eliminated.

The cargo space of two or three years ago was 50 to 60 cubic feet for approximately 1,000 pounds of useful load with 400 horsepower. Now, we find many planes of 200 horsepower with a similar load capacity and double the cargo space, and at the same or better speed. The cause is found in the greater efficiency in design and construction of both aircraft and engines.

With the same assurance offered by train, air service now furnishes a 10-hour schedule between New York and Chicago; 30 hours to the Golden Gate; and overnight to Florida. This illustrates the speed of air transportation, undoubtedly the greatest advantage this vehicle offers. Night flying will increase as fast as the department is able to install the lights along the airways.

The cost of air-transport operation is yet a problem, but it is being rapidly overcome as the volume of business increases. Many of the commercial companies now, while being obliged to maintain a complete overhead, are operating at only a fraction of cargo capacity. This situation will adjust itself and the costs will be more efficiently distributed. The differential in speed, however, between air travel and other methods of transportation is important and must be taken into account when determining comparative costs. The cost of air transport to the traveler is surprisingly low when the time element is considered.

WEATHER AND FLIGHT

Though the airplane in emergency is often the sole means of communication, yet its operations in scheduled daily service are affected to some extent by weather, practically the only hindrance to perfect performance.

Of the 5,272 trips scheduled on civil airways during the first half of 1927, 623 of the 685 trips which were defaulted were chargeable to bad weather.

The difficulty of night flying is being rapidly overcome by lighting and other aids to navigation.

Of all weather conditions described as bad, fog presents the greatest hazard. Research and experimental work is being conducted at the Bureau of Standards to overcome this, however, by the development of suitable navigation instruments. An unofficial committee organized by the Guggenheim Fund for the Promotion of Aeronautics, which includes representatives of various Government bureaus, is likewise endeavoring to further research in the elimination of fog as a prohibitive of flight.

AIR ACCIDENTS

Under the air commerce act accidents are required to be investigated and reported, and the department is now performing this function.

CASUALTIES IN AIRWAY FLYING

Casualties in scheduled airway flying are comparatively rare.

In 1926 the Government-operated transcontinental suffered one pilot fatality. One occurred during the first half of the calendar year 1927. Weather conditions were responsible for one of these accidents. The exact cause of the other is unknown.

On the contract routes there were three pilot fatalities and one passenger fatality in 1926. Three accidents were ascribed to weather. One was of undetermined cause. During the first half of the calendar year 1927 there were two pilot and one passenger fatalities, in two accidents, both chargeable to weather.

Pilot examinations, plane inspections, and the lighting, weather service, and other aids to airway flying, now installed or in the department's program, should practically eliminate accidents in scheduled flying.

CASUALTIES IN MISCELLANEOUS FLYING

In air service operations and miscellaneous flying it is expected that casualties will be more frequent; but here, also, the enforcement of precautionary measures and the utilization of the Government's facilities will decrease the casualty rate.

During the last half of the fiscal year 1927, 15 pilots and 28 passengers were killed in 25 airplane accidents in this country. These accidents occurred in course of "taxi" service and pleasure rides, test flights, and instruction. Thirteen of the accidents were ascribed to error in pilotage, 3 to power-plant failure, 2 to weather, and 7 to structural failure. Practically all these accidents occurred with unlicensed pilots and in unlicensed planes.

AIRCRAFT PRODUCTION AND TRADE

The aircraft industry is in the position of being far behind on orders. It is reasonably expected that the production of airplanes during the calendar year 1927 will at least double that of 1926. Even this may be too moderate an estimate.

In a special count made by the Bureau of the Census in cooperation with the aeronautics branch of the department, the 1926 output of

the manufacturing industry was 1,186 planes valued at \$8,871,027 as against 789 in 1925 with a valuation of \$6,673,659.

The military services, the Department of Agriculture, and the Post Office Department took 328 of the 1926 planes, and 50 were exported, leaving 808 as the minimum civil consumption. In addition, air-service operators produced approximately 150 planes.

The total value of work done in 1926 by establishments engaged primarily in the manufacture of airplanes was \$24,161,752, including the value of airplane engines, amounting to \$4,080,571, made by establishments engaged primarily in the manufacture of such engines. The total value of products reported for 1926 by establishments in the aircraft industry proper is \$20,081,181, as compared with \$12,524,719 for 1925, an increase of 60.3 per cent.

It might be said that the present civil demand represents but the initial production of a new industry. Civil aeronautics has, in the main, been operating on war surplus. The demand for modern planes, the diminution of war supply, the development of better engines, and the application of Federal inspection, combined with the widespread acceptance of the airplane in business promise an increase of which any estimate must be but a guess.

EXPORTS

During the calendar year 1926 the total value of United States exports of aircraft, aeronautical engines, and parts for planes increased satisfactorily over those of 1925. Specifically, they increased \$243,551 over the 1925 total of \$783,659, showing a valuation of over \$1,000,000. This is very encouraging in view of the number of sales made in Latin America by European companies during the past year, American manufacturers finding their prices very difficult to meet due to European currency depreciation.

The record of the first half of 1927 forecasts another increase for the full year.

The greater part of the increase in exports was registered in aircraft engines, the number of units showing an increase from 73, valued at \$170,793, in 1925 to 297, with a valuation of \$573,732, in 1926. However, the average engine unit value decreased 14.5 per cent during the same period, indicating that a much greater percentage of salvage types was exported in the latter year.

The number of planes exported decreased from 80 to 50 units during the same period. Here again the unit value decreased somewhat, as the 1925 exports of planes were valued at \$511,282, while the value of exported planes fell to \$303,149 in 1926. Airplane parts showed an increase of nearly 50 per cent, from a valuation of \$101,584 in 1925 to \$150,329 in 1926.

The United Kingdom was our leading market for aircraft products in 1926, taking \$281,050 of the total. Soviet Russia was second, our exports to that country totaling \$270,739; Peru was third, with \$120,231; Mexico fourth, with \$85,459; and Canada fifth, with \$47,276.

For the first half of 1927 exports of airplanes decreased from 26 units for the same period in 1926 to 19, but the unit value increased from \$4,729 to \$16,400, indicating purchases of modern, new planes. Latin America was our leading market with a total of \$239,919.

Engine exports in 1927 show a decline both in number and value, when contrasted with the same period of 1926. However, the situation is not discouraging, as with a few exceptions exports of aircraft engines consisted of new engines of relatively high unit value. The wide distribution of these exports would indicate also that the majority were experimental orders. The low unit value of \$1,795 in 1927 is accounted for by the fact that 53 engines, with an average unit value of \$456, were exported to Canada. Of the remainder, 13 engines had an average valuation of \$7,572 each.

The export value of aircraft parts during the first six months of 1927 was almost 100 per cent higher than during the same period of 1926. One-third of the total during the present calendar year has gone to Canada. Furthermore, the exports of parts to Canada during the first six months of the year far exceeded the total exports of aircraft, engines, and parts to that country during the entire calendar year 1926. Soviet Russia in Europe and the United Kingdom also loomed up relatively large as export markets for aircraft parts during the present year, as did Chile in the Western Hemisphere.

TRADE PROMOTION

In early May the department initiated the national aircraft show and flight demonstration at Bolling Field during the annual convention of the United States Chamber of Commerce and the sessions of the Pan-American Commercial Conference and the Inter-American Air Commission. The business men of North and South America and a number of American railroad executives were shown a great many of the latest types of civil and military aircraft, with all air-navigation accessories, and more than a thousand visitors were given flights. This was the most comprehensive aeronautical display ever held in this country and gave evidence of the security of aeronautics as a business.

During the year the first directory of the industry was compiled in the department. It has run through several editions and is constantly being enlarged. It lists 900 firms, corporations, or individuals engaged in different phases of the aeronautical industry.

III. CONCLUSION

AIM OF THE AERONAUTICS BRANCH

It is the aim of the Department of Commerce to assist in bringing about a combination of four elements which are considered essential to the success of civil aeronautics in this country: (1) Airworthy aircraft, adequately equipped and efficiently maintained, and (2) flown by competent pilots over (3) suitably equipped airways (4) in conformity with standard air-traffic rules. When this has been accomplished the public will take air transport for granted, as it does the railroad, the steamship, and the automobile.

Very truly yours,

CLARENCE M. YOUNG,
Director of Aeronautics.

APPENDIX

Following are tables relating to air transport in the United States, statistics of civil airways, aircraft production, exports, etc.

TABLE A.—Air transport routes in the United States July 1, 1924, to June 30, 1927

[Route miles in operation June 30, 1927, 8,396]

Route	Mileage	Service commenced	Present schedule	Operator	Service
San Francisco-New York ^{1, 2}	2, 612	July 1, 1924 ³	Daily	U. S. Post Office Department	Mail.
Seattle-Victoria	77	Oct. 15, 1920	12 round trips a month, average	Northwest Air Service ⁴	Mail and passenger.
Pilottown-New Orleans	75	Apr. 9, 1923	27 round trips a month, average	New Orleans Air Line ⁴	Mail.
San Diego-Los Angeles ^{5, 6}	112	Mar. 1, 1925		Ryan Air Lines	Passenger.
Chicago-New York, overnight ^{2, 6, 1}	718	July 1, 1925	Daily	U. S. Post Office Department	Mail.
Key Largo-Key West ⁷	100	Jan. 1, 1926		Fairchild Aviation Corporation	Passenger.
Detroit-Cleveland	155	Feb. 15, 1926	6 days a week ⁸	Ford Motor Co. ⁴	Mail and express.
Detroit-Chicago	252	do	do	do ⁴	Do.
Miami-Atlanta ^{9, 6}	740	Apr. 1, 1926		Florida Airways ⁴	Mail, express, and passenger.
Salt Lake City-Pasco	535	Apr. 6, 1926	6 days a week	Walter T. Varney ⁴	Mail.
St. Louis-Chicago	268	Apr. 15, 1926	5 days a week ¹⁰	Robertson Aircraft Corporation ⁴	Mail, express, and passenger.
Los Angeles-Salt Lake City ²	633	Apr. 17, 1926	Daily	Western Air Express ⁴	Do.
Dallas-Chicago ²	995	May 12, 1926	do	National Air Transport ⁴	Mail.
Pueblo-Cheyenne	200	May 31, 1926	do	Colorado Airways ⁴	Mail and passenger.
Chicago-Minneapolis-St. Paul	399	June 7, 1926	5 days a week	Northwest Airways ⁴	Mail.
New York-Boston ²	219	July 1, 1926	6 days a week ⁸	Colonial Air Transport ⁴	Mail, express, and passenger.
Washington-Philadelphia-Norfolk ^{11, 6}	234	July 6, 1926	Twice daily	Philadelphia Rapid Transit ⁴	Do.
Detroit-Grand Rapids	140	Aug. 2, 1926	6 days a week	Stout Air Services	Express and passenger.
Los Angeles-Seattle	1, 152	Sept. 15, 1926	do	Pacific Air Transport ⁴	Mail, express, and passenger.
Detroit-Buffalo	218	Mar. 28, 1927	do	Ford Motor Co.	Express.
Pittsburgh-Cleveland	121	Apr. 21, 1927	Daily	Clifford Ball ⁴	Mail.
Louisville-Cleveland	345	May 18, 1927	6 days a week	Embry Riddle Co.	Express and passenger.

¹ On July 1, 1927, the San Francisco-Chicago portion of the Government operated transcontinental route is to be taken over by the Boeing Air Transport, and on Sept. 1, 1927 the remaining section, Chicago-New York day and night service, will be taken over by the National Air Transport.

² Beginning Sept. 1, 1927, this route will carry express under contract with the American Railway Express Co.

³ On May 15, 1920, combination rail and airplane transcontinental service began. Through transcontinental air service began July 1, 1924.

⁴ Air-mail contractor. ⁵ Discontinued, 1926. ⁶ Not included in total mileage. ⁷ Discontinued Apr. 12, 1926. ⁸ Except holidays.

⁹ Began Apr. 1, 1926, between Jacksonville and Miami, and Sept. 15, 1926, between Atlanta and Jacksonville; discontinued Dec. 31, 1926.

¹⁰ Except holidays and days following.

¹¹ Operated during the Sesquicentennial Exposition only; discontinued Nov. 30, 1926.

TABLE B.—*Scheduled flying on civil airways, calendar year 1926*

Route	Months operated	Miles flown, scheduled trips	Passengers carried ¹	Mail carried (pounds)	Express carried (pounds)	Air mail income
San Francisco-New York.....	12	1,860,180	0	286,028	0	-----
Chicago-New York overnight.....	12	432,083	0	147,621	0	-----
M Boston-New York.....	6	50,708	0	6,630	0	\$19,912.87
M St. Louis-Chicago.....	9	99,127	0	22,718	0	50,459.13
M Dallas-Chicago.....	8	445,375	0	63,191	0	174,172.14
M Los Angeles-Salt Lake City.....	9	302,369	258	76,564	360	199,777.73
M Salt Lake City-Pasco.....	9	161,356	0	33,241	0	95,000.73
M Detroit-Cleveland.....	11	47,684	0	1,721	1,033,338	1,858.79
M Detroit-Chicago.....	11	117,791	0	5,830	696,197	6,268.11
M Los Angeles-Seattle.....	5	166,509	² 33	19,645	0	55,559.82
M Chicago-Minneapolis-St. Paul.....	7	145,462	0	7,235	0	17,453.22
M Pueblo-Cheyenne.....	8	74,916	³ 200	17,135	100	47,259.69
M Pilottown-New Orleans.....	12	40,050	0	51,696	0	28,006.85
M Seattle-Victoria.....	12	19,266	0	55,839	0	27,500.00
M Atlanta-Miami.....	9	210,761	939	14,336	0	38,187.88
M Philadelphia-Norfolk.....	5	93,770	3,695	1,425	0	4,132.22
Detroit-Grand Rapids.....	3	31,680	657	0	3,155	-----
San Diego-Los Angeles.....	-----	31,000	(⁴)	0	(⁴)	-----
Key Largo-Key West.....	-----	15,000	(⁴)	0	(⁴)	-----
Total.....	-----	4,318,087	5,782	810,855	1,733,090	765,549.18

M=Mail contract routes.

¹ But six lines accepted scheduled passenger business in 1926. The fare averaged 14 cents a passenger-mile. Other lines preferred to wait out a trial period of air operations.² Carried 69 passengers on short flights about the airport in addition.³ Carried 1,400 passengers on short flights about the airport in addition.⁴ No data.TABLE C.—*Scheduled flying on civil airways, January-June, 1927*

Route	Miles flown, scheduled trips	Passengers carried ¹	Mail carried, pounds	Express carried, pounds	Air-mail income
San Francisco-New York ²	913,031	0	212,976	0	-----
Chicago-New York overnight ²	233,417	0	88,048	0	-----
M New York-Boston ²	53,020	231	8,164	100	\$24,488.06
M St. Louis-Chicago.....	63,987	2	16,999	21,651	43,024.77
M Dallas-Chicago ²	343,768	59	51,274	0	153,654.36
M Los Angeles-Salt Lake City ²	204,972	147	88,746	20	266,235.93
M Salt Lake City-Pasco.....	147,340	0	22,612	0	67,838.63
M Detroit-Cleveland ³	78,144	0	826	646,599	894.30
M Detroit-Chicago ³	81,732	0	4,741	364,099	5,120.85
M Los Angeles-Seattle.....	212,454	318	31,420	0	89,374.89
M Chicago-Minneapolis-St. Paul.....	88,320	0	11,418	0	31,400.70
M Cleveland-Pittsburgh ⁴	16,959	4	4,674	0	14,020.87
M Pueblo-Cheyenne.....	72,400	2	15,606	0	46,819.49
M Pilottown-New Orleans.....	25,920	0	37,896	0	16,208.10
M Seattle-Victoria.....	10,764	11	25,836	0	14,200.00
Detroit-Grand Rapids.....	41,300	1,087	0	2,404	-----
Louisville-Cleveland.....	23,940	30	0	244	-----
Detroit-Buffalo ³	30,956	0	0	10,105	-----
Total.....	2,642,364	1,891	621,236	1,045,222	773,280.95

M=Mail contract routes.

¹ While most contract air-mail routes have been carrying passengers who request passage, but eight have published passenger rates. The average passenger-mile rate is 13 cents plus.² Beginning Sept. 1, 1927, this line will carry express under contract with the American Railway Express Co.³ Private express.⁴ Began Apr. 21, 1927.

TABLE D.—*Miscellaneous flying of airway operators, January-June, 1927*

Route	Airplane-miles ¹	Passengers carried	Express carried, pound
San Francisco-New York.....	92,946	0	0
Chicago-New York overnight.....		0	0
M New York-Boston.....	26,268	2,200	0
M St. Louis-Chicago.....	88,720	2,105	1,690
M Dallas-Chicago.....	31,018	0	0
M Los Angeles-Salt Lake City.....	1,681	4	0
M Salt Lake City-Pasco.....	9,245	0	0
M Detroit-Cleveland.....	2,600	0	0
M Detroit-Chicago.....	2,500	0	0
M Los Angeles-Seattle.....	8,280	34	0
M Chicago-Twin Cities.....	0	0	0
M Cleveland-Pittsburgh.....	3,044	21	0
M Pueblo-Cheyenne.....	800	180	0
M Pilotown-New Orleans.....	0	50	0
M Seattle-Victoria.....	0	0	0
Detroit-Grand Rapids.....	11,220	2,411	0
Louisville-Cleveland.....	83,625	1,300	260
Detroit-Buffalo.....	(²)	0	0
Total.....	362,249	8,305	1,950

M=Mail contract routes.

¹ This mileage includes taxi service, test flights, ferry flying, and other nonscheduled flights.² No data.TABLE E.—*Trips completed and uncompleted on civil airways January-June, 1927*

Route	Trips scheduled	Completed	Incompleted ¹	Not started ¹
San Francisco-New York.....	362	² 182	180	0
Chicago-New York overnight.....	362	² 306	34	22
M New York-Boston.....	302	241	20	41
M St. Louis-Chicago.....	240	231	9	0
M Dallas-Chicago.....	362	287	75	0
M Los Angeles-Salt Lake City.....	362	348	13	1
M Salt Lake City-Pasco.....	332	278	26	28
M Detroit-Cleveland.....	574	528	0	46
M Detroit-Chicago.....	306	294	1	11
M Los Angeles-Seattle.....	310	198	112	0
M Chicago-Twin Cities.....	258	230	22	6
M Cleveland-Pittsburgh.....	142	133	7	2
M Cheyenne-Pueblo.....	362	362	0	0
M Pilotown-New Orleans.....	324	324	0	0
M Seattle-Victoria.....	142	138	4	0
Detroit-Grand Rapids.....	306	295	1	10
Louisville-Cleveland.....	74	70	2	2
Detroit-Buffalo.....	152	142	0	10
Total.....	5,272	4,587	506	179

M=Mail contract routes.

¹ Failures to start or complete trips were ascribed to the following causes: Weather and darkness 623; structural, 4; mechanical, 28; shortage of equipment, 30; total, 685.² All trips on which mails were trained over any portion of the trip are counted as incomplete, but the mails were advanced practically in all instances.

TABLE F.—Air mail contract rates

Route	Rate per pound
New York-Boston-----	\$3.00
Chicago-St. Louis-----	2.53
Dallas-Chicago-----	3.00
Los Angeles-Salt Lake City-----	3.00
Salt Lake City-Pasco-----	3.00
Detroit-Cleveland-----	1.08
Detroit-Chicago-----	1.08
Los Angeles-Seattle:	
Up to 1,000 miles-----	2.81
Entire route-----	3.09
Chicago-Minneapolis-St. Paul-----	2.75
Cleveland-Pittsburgh-----	3.00
Pueblo-Cheyenne-----	3.00
Atlanta-New York-----	3.00
Chicago-San Francisco-----	¹ 1.50
Chicago-New York-----	² 1.24
Cleveland-Albany-----	1.11
Laredo-Dallas-----	2.89
Galveston-Dallas-----	2.89
New Orleans-Atlanta-----	1.75
Average rate per pound-----	2.406
Foreign routes: ³	
Havana-Key West-----	.405
Pilottown-New Orleans-----	(⁴)
Seattle-Victoria-----	(⁴)

¹ Up to 1,000 miles; 15 cents for each 100 miles over 1,000.² Up to 1,500 pounds a day; thereafter a reduction of 5 per cent for each additional 500 pounds.³ All mail handled on these routes is ordinary first class at 2-cent rate.⁴ The rate on the Pilottown-New Orleans route is \$110 per round trip; on the Seattle-Victoria route, \$190 per round trip.

TABLE G.—Activities of "air service operators," calendar year 1926

Item	Reported	Estimated	Total
Number of operators engaged-----	250	335	585
Passengers carried for hire-----	288,470	388,097	676,657
Passengers carried free-----	40,748	53,605	94,353
Airplane-hours flown-----	99,978	134,335	234,315
Pay freight, pounds-----	178,791	240,195	418,986
Students trained-----	1,910	2,556	4,466
New planes produced-----	63	87	150
Planes remodeled-----	502	670	1,172
Planes in service-----	572	770	1,342
Airplane-miles flown (based on 80 miles per hour)-----	7,998,240	10,748,400	18,746,640

TABLE H.—*Aircraft production—Calendar years 1925 and 1926*

Item	1926	1925
Number of establishments.....	¹ 67	44
Products, total value.....	\$24, 161, 752	² \$12, 524, 719
Airplanes:		
Number.....	³ 1, 179	711
Value of work done during year.....	\$8, 771, 077	\$5, 908, 335
Seaplanes:		
Number.....	⁴ 7	78
Value of work done during year.....	\$99, 950	\$765, 324
Aircraft of all classes under construction at close of year:		
Number.....	508	259
Value of work done during year.....	\$2, 377, 769	\$1, 428, 447
Engines made by establishments reporting: ⁵		
Water-cooled—		
Sold separately or for sale—		
New construction—		
Number.....	444	-----
Value of work done during year.....	\$3, 527, 432	-----
Rebuilt and reassembled—		
Number.....	770	-----
Value of work done during year.....	\$548, 160	-----
Installed in own aircraft—		
New construction—		
Number.....	62	-----
Value of work done during year.....	\$20, 800	-----
Rebuilt and reassembled—		
Number.....	33	-----
Value of work done during year.....	\$21, 750	-----
Air-cooled—		
Sold separately or for sale—		
New construction—		
Number.....	325	-----
Value of work done during year.....	\$2, 847, 988	-----
Rebuilt and reassembled—		
Number.....	3	-----
Value of work done during year.....	\$582	-----
Installed in own aircraft—		
New construction—		
Number.....	3	-----
Value of work done during year.....	\$1, 875	-----
Engine parts made during year and engines under construction at close of year, value.....	\$560, 932	-----
Aircraft parts, value.....	\$4, 553, 910	\$3, 508, 460
All other products, including repair work, value.....	\$829, 527	\$914, 153
Engines purchased for installation: ¹		
New construction—		
Number.....	842	-----
Value of work done during year.....	\$548, 566	-----
Rebuilt and reassembled—		
Number.....	358	-----
Value of work done during year.....	\$88, 286	-----

¹ Includes 3 establishments with products valued at less than \$5,000 and 5 establishments engaged primarily in the manufacture of aircraft engines.

² Does not include secondary products of other industries valued at \$250,462.

³ Includes 54 convertible airplanes, and 171 rebuilt and reassembled.

⁴ Includes 2 rebuilt and reassembled.

⁵ No data available for aircraft engines for 1925 as the output of establishments primarily engaged in the manufacture of aircraft engines is included in the statistics for the "engines and water wheels" industry in the regular biennial censuses.

TABLE I.—*Aircraft products, by number and value, calendar years 1919–1926*¹

Item	1926	1925	1923	1921	1919
Total value.....	² \$24,161,752	\$12,775,181	\$13,142,364	³ \$7,430,824	\$14,372,643
The aircraft industry.....	² 24,161,752	12,524,719	12,945,263	³ 6,652,981	14,372,643
Secondary products of other industries.....	(⁴)	⁵ 250,462	⁵ 197,101	⁵ 777,843	(⁴)
Airplanes:					
Number.....	1,179	711	505	290	432
Value.....	\$8,771,077	\$5,908,335	\$6,166,218	\$3,818,340	\$3,466,452
Seaplanes:					
Number.....	7	78	82	12	230
Value.....	\$99,950	\$765,324	\$1,570,851	\$314,768	\$4,580,016
Under construction at close of year (both classes):					
Number.....	508	259	281	374	341
Value.....	\$2,377,769	\$1,428,447	\$1,339,737	\$966,322	\$1,658,670
Parts and engines for sale.....	12,083,429	3,794,885	2,839,294	901,619	2,601,995
All other products, including repair work, value ⁶	829,527	878,190	1,226,264	1,429,775	2,065,510

¹ The census of manufactures was taken at five-year intervals prior to 1919, but has since been taken at two-year intervals. The census of the aircraft industry for 1926 was a special one. The statistics for the aircraft industry were not published in detail for years prior to 1919. At the census for 1914, 16 establishments reported the manufacture of aircraft and parts. The production of airplanes, seaplanes, and parts for that year was valued at \$481,022; the receipts for repair work amounted to \$209,481; and the value of "all other products" was reported as \$99,369. The data for any establishments engaged in the manufacture of aircraft in 1909 were included with those for manufacturers of motor cycles, bicycles, and parts.

² Includes output of 3 establishments with products valued at less than \$5,000 and of 5 engaged primarily in the manufacture of aircraft engines.

³ Includes \$10,993 reported by 4 establishments, each having products valued at less than \$5,000.

⁴ No data.

⁵ Parts only.

⁶ Experimental work, pontoons, airships, automobile bodies, sea sleds, and other miscellaneous items.

TABLE J.—*United States exports of aeronautical products, calendar years 1922–1927*

Item	Number	Value	Item	Number	Value
1922:			1925:		
Planes.....	37	\$156,630	Planes.....	80	\$511,282
Engines.....	147	72,819	Engines.....	73	170,793
Parts for planes.....		265,481	Parts for planes.....		101,584
Total value.....		494,930	Total value.....		783,659
1923:			1926:		
Planes.....	48	309,051	Planes.....	50	303,149
Engines.....	80	65,558	Engines.....	297	573,732
Parts for planes.....		58,949	Parts for planes.....		150,329
Total value.....		433,558	Total value.....		1,027,210
1924:			First half 1927:		
Planes.....	59	412,738	Planes.....	19	311,610
Engines.....	146	219,609	Engines.....	69	123,892
Parts for planes.....		165,926	Parts for planes.....		189,178
Total value.....		798,273	Total value.....		624,680

TABLE K.—*Fatalities in airway operations and airplane miles per fatality, calendar years 1918–1927*

FATALITIES IN AIRWAY OPERATIONS								
Calendar year	Post-office mail			Contract mail			Other airway operations	
	Miles*	Fatalities		Miles ¹	Fatalities		Miles	Fatalities
		Pilots	Passengers		Pilots	Passengers		
1927 (6 months).....	1,239,394	1	0	1,399,720	2	1	96,196	0
1926.....	2,583,056	1	0	1,958,144	3	1	77,680	0
1925.....	2,521,758	1	0	(2)	(2)	(2)	(3)	(3)
1924.....	2,161,077	3	0	(2)	(2)	(2)	(3)	(3)
1923.....	1,870,422	5	1	(2)	(2)	(2)	(3)	(3)
1922.....	1,756,803	1	0	(2)	(2)	(2)	(3)	(3)
1921.....	1,912,733	7	2	(2)	(2)	(2)	(3)	(3)
1920.....	1,048,444	8	6	(2)	(2)	(2)	(3)	(3)
1919.....	461,295	4	0	(2)	(2)	(2)	(3)	(3)
1918.....	102,548	1	0	(2)	(2)	(2)	(3)	(3)
Total.....	15,657,530	32	9	3,357,864	5	2	-----	-----

AIRPLANE MILES PER PILOT FATALITY

Calendar year	Post-office mail	Contract mail ²	Other airway operations
1927 (6 months).....	1,239,394	699,860	0
1926.....	2,583,056	652,715	0
1925.....	2,521,758	-----	-----
1924.....	720,359	-----	-----
1923.....	374,084	-----	-----
1922.....	1,756,803	-----	-----
1921.....	273,248	-----	-----
1920.....	131,056	-----	-----
1919.....	115,324	-----	-----
1918.....	102,548	-----	-----

*Miles flown both in scheduled operations and in ferry, test, and other nonscheduled flights.

¹ Miles flown in scheduled operations, not including ferry, test, or other nonscheduled flights.² No contract mail prior to 1926 save for the 2 foreign routes from New Orleans and Seattle. No casualties on either of these.³ From 1911 to 1925 there have existed from time to time passenger lines between various points in the United States, but there is no official record of their operations.